C3000/C3000A SCR CONTROL CARD USER MANUAL

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1.0 INTRODUCTION

Thank you for purchasing the C3000 SCR control card. Please read these instructions carefully before installing and running your controller.

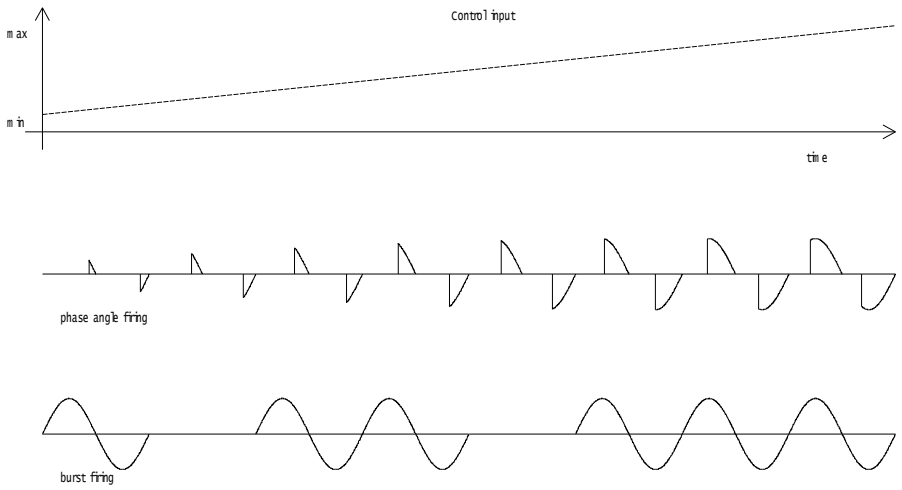
The C3000 control card is designed for firing SCRs in three phase rectifier and AC power control applications. The C3000A accessory card allows options such as current limit and current trip, operation as a current source and relay outputs.

1.1 PRINCIPAL OF OPERATION

The C3000 controller can be operated in either burst or phase angle firing mode.

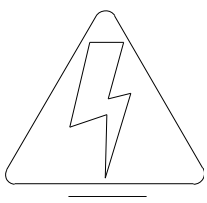
In burst firing mode the controller rapidly switches the output on and off in response to the control input signal.

In phase angle firing mode the controller conducts over a variable portion of the incoming AC cycle in response to the control input signal.



1.2 SAFETY

This instruction manual gives details of safe installation and operation of the C3000.
Note that there are mains voltages present within the C3000 enclosure and on parts of the control electronics circuit board. High voltage areas on the circuit board are marked by:



2.0 INSTALLATION

2.1 MOUNTING

The C3000 card has mains level voltages present on it. Mount so that there is at least 15mm between the bottom of the card and the mounting surface.

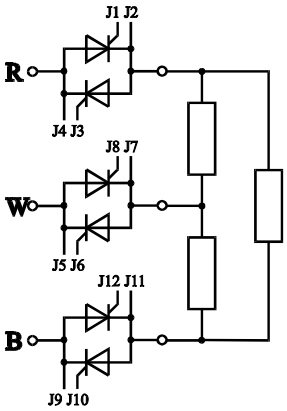
2.2 WIRING

2.2.1 SCR CATHODE & GATE WIRING

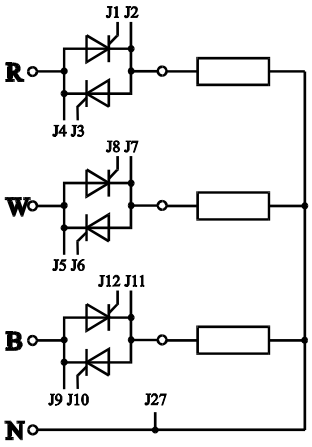
SCR gates and cathodes connect to the C3000 control card through quick connect terminals J1 to J12. Wire the control card exactly as per the diagram. The C3000 card is phase rotation sensitive, the phase sequence must be R, W, B as shown in the schematics below.

AC OUTPUT

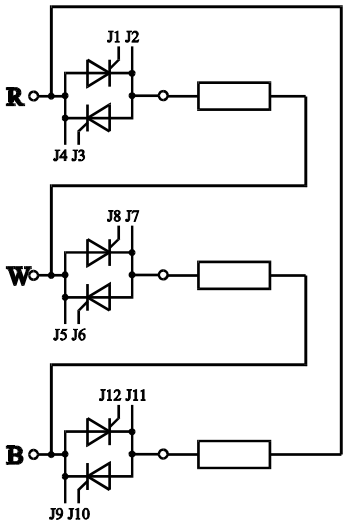
3 WIRE



4 WIRE

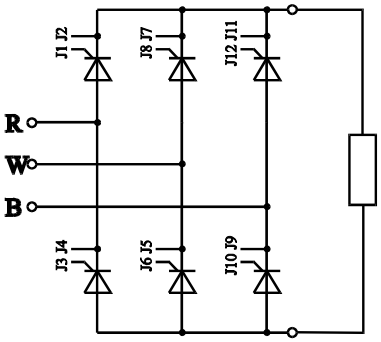


6 WIRE

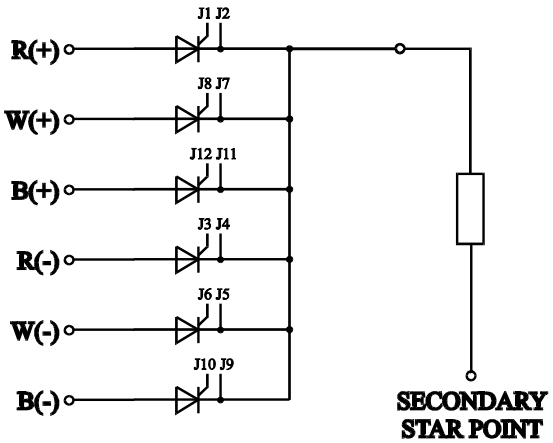


DC OUTPUT

FULL BRIDGE



DOUBLE STAR



The power for the card is taken through the auxiliary cathode leads in all cases **except for DOUBLE STAR (DC)**
For double star dc the tracks under the board marked with an "X" will need to be cut and R, W, B connected to J15, J16 and J17 respectively.
If the supply voltage for the card is to be different to the supply voltage for the SCR's then the tracks under the board marked with an "X" will need to be cut and R, W, B connected to J15, J16 and J17 respectively.

2.2.2 STACK OVERTEMPERATURE SWITCH

Quick connect terminals J25 and J26 are provided for connection to a thermal switch that monitors the SCR stack temperature. The thermal switch should be volt free and normally closed. If a stack over temperature switch is not to be used terminals J25 and J26 must be linked.

2.2.3 RELAY OUTPUTS

Optional meter outputs are available to signal the status of card ‘enable’, SCR ‘over temperature’, current ‘trip’, ‘phase loss’, ‘element life’ and ‘partial load failure’. The maximum relay current is 5 amps.

2.2.4 PULSE OUTPUTS

An optional pulse output feature gives a pulse output with frequency proportional to either current, power or voltage.

2.2.5 METERS

Three optional 0-1mA meter outputs are available for transmission of output voltage, current or power. If necessary, meter (-) terminals can be made common.

2.2.6 ENABLE LINK

An ENABLE link is provided on screw terminals 1 and 2 which must be closed for the C3000 to operate.

The ENABLE link can be used as a convenient means of turning the controller on and off. Ensure that any contacts switching the enable link are volt free.

Note that the enable link must not be used as a safety interlock. It does not mechanically disconnect the SCR from the power supply and cannot be used as a means of safety isolation.

2.2.7 NEUTRAL

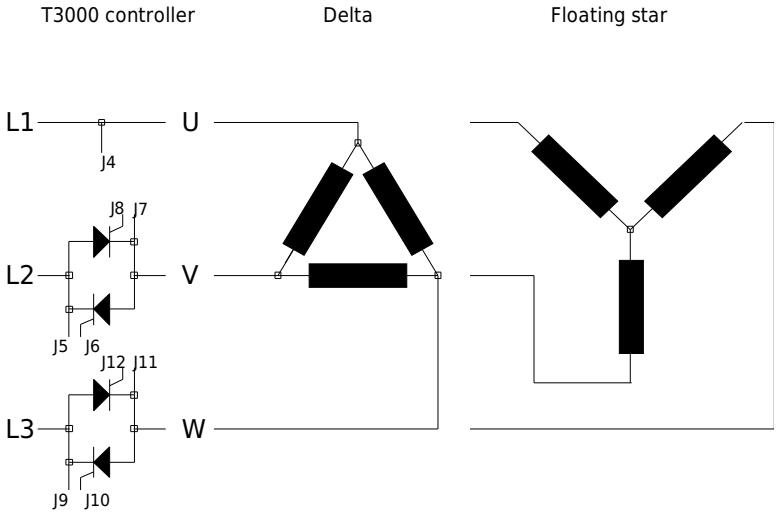
All units with the 4W option have a neutral terminal that **must** be wired in. Failure to do this will result in incorrect operation.

The neutral connection to the C3000 is for the AC fan(s) (where fitted) and as a phase reference for the controller. It can be run in light gauge wire.

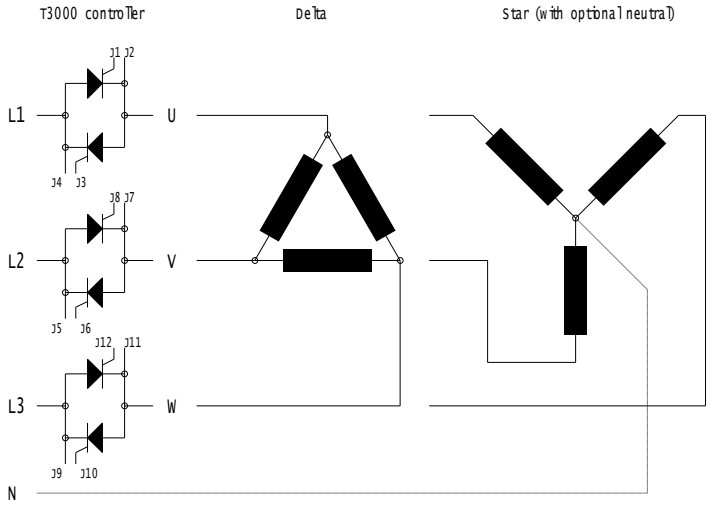
2.2.8 POWER WIRING

Incoming three phase power supply **must** be wired in the correct sequence, R-W-B corresponds 120 degrees between phases.

The load can be wired in floating star, star with neutral, delta and six wire delta. **If the load is star with neutral the 4W (four wire) option must be specified.**



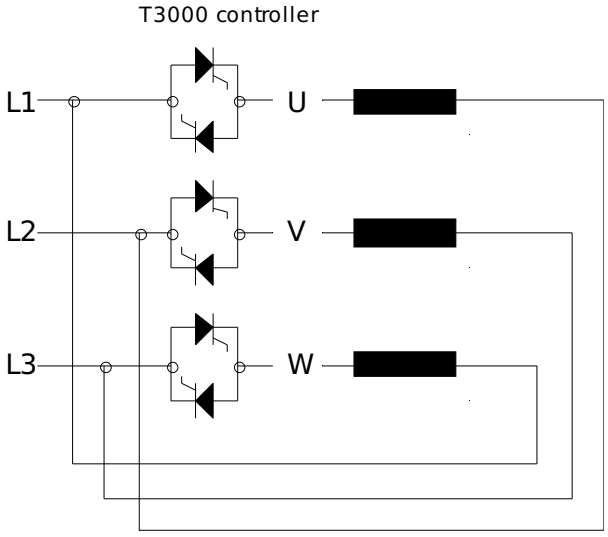
Load configuration-T3002 two leg control



Load configuration- T3003 three leg control

2.2.9 POWER WIRING FOR SIX WIRE DELTA LOADS

When used with six wire loads the incoming three phase power supply must be wired in the correct sequence, R-W-B, and also the returns from the heating load must be wired in the correct sequence.



Six wire load configuration

2.3 AC VOLTAGE FEEDBACK FOR SIX WIRE LOADS

If the C3000 controller is to be used with a six wire load and has the AC voltage feedback option wire link LK8 must be removed and replaced by link LK9. Link LK7 is used only for four wire loads.

These links are found on the C3000 circuit card. The following table summarises the AC voltage feedback link configuration.

Load Configuration	LK7	LK8	LK9
Four wire-star with neutral	IN	OUT	OUT
Three wire-star or delta*	OUT	IN	OUT
Six wire-delta	OUT	OUT	IN

*Default configuration for non four wire controllers.

2.4 TRANSFORMER PRIMARY CONTROL

The C3000 can safely be used to control transformer coupled loads through the transformer primary with the following recommendations:

- The controller **must** be set to phase angle mode firing.
- The current or power limit/trip option is highly recommended to protect the transformer from DC saturation in the event of a partial SCR failure.
- The normal transformer configuration is delta primary star secondary.

2.5 TRANSFORMER SECONDARY CONTROL

The C3000 can be used on the secondary of any transformer provided the voltage specified for the C3000 is the same as the transformer secondary voltage.

2.6 FUSING

Fuses supplied with the C3000 are special fast fuses for the protection of the SCRs only. Wiring and other circuit elements must be fused separately with circuit breakers or HRC fuses.

2.7 ISOLATION

SCRs and their RC protection networks (snubbers) inherently leak voltage. High voltages will be present on their output terminals even when in the off state. For this reason **the C3000 SCR cannot be relied upon as an isolating device**. The C3000 must be installed with a mechanical circuit breaking device in series with its supply so that work can be safely carried out on the unit.

2.8 ENCLOSURE VENTILATION

The C3000 is designed to operate at a maximum ambient temperature of 50 degrees C. The electrical enclosure must have adequate ventilation to ensure that the internal temperature does not rise to a point above 50 degrees C. In some cases forced ventilation is appropriate.

3.0 COMMISSIONING

3.1 FIRING MODE SELECTION

Two types of firing modes are available on the C3000, phase angle and fast cycle burst. To select move the selector jumper to the 'phase' or 'burst position as required. Note that some options will not work correctly if the firing mode is changed. Note also that some types of heating elements and transformer coupled loads should only be used with phase angle control. If in doubt about the correct firing mode for your application contact us.

	Required firing mode	Comments
Current limit & trip	either	Phase control-instantaneous limit Burst control-average limit
Power limit	phase	Phase control-instantaneous limit Burst control-average limit
Current meter output	either	
Voltage meter output	either	
Power meter output M2, M3	phase	
Partial load failure PLF	burst	
Element 'end of life' indication EL	phase	
AC voltage feedback AVF	phase	
Phase loss	either	
Current source mode CCS, CCH, CCA	phase	
T3002	burst	Two leg control

3.2 START UP

The controller must be connected to a load in order to run correctly. After switching power to the controller on the 'POWER', 'POWER OK', and 'ENABLE' leds should be lit.

If the 'POWER' led is unlit check that all three phases are present and that the fuses are not blown.
The 'POWER OK' led indicates that the phase rotation is correct. If it is unlit swap two incoming phases around.
If the 'ENABLE' led is unlit bridge out terminals 1 and 2 with wire or through volt free contacts.

3.3 ADJUSTMENTS

Adjustments are made by potentiometers on the electronic circuit cards. Refer to section 7.0 for detail of potentiometer positions. **Note that potentially lethal mains level voltages are present on these circuit cards and on power components within the C3000 enclosure-adjustments should be carried out by suitably qualified personnel.**

There are several sealed potentiometers that are factory set and must not be adjusted by the user.

3.3.1 ZERO AND SPAN

Zero and span adjustment ensures that the controller output is from 0 to 100% over the full control input range.

Your C3000 is supplied pre calibrated. This procedure need only be carried out as a periodic calibration check. In practice any slight errors in calibration will be compensated for by the temperature controller or PLC controlling the C3000
When performing this adjustment the SCR is set to maximum output power for a short time. Many heaters have a maximum power density that cannot be exceeded or damage will occur. For this reason it is

strongly recommended that for this adjustment the heaters be disconnected from the SCR and a 'dummy' load used instead. We can supply a compact portable dummy load or alternatively you can assemble one from household light bulbs.

3.3.2 ZERO ADJUSTMENT

With the dummy load connected set the control input signal to minimum, i.e. 4 mA, 0 VDC or 0 ohms. Connect a volt meter across the SCR output and adjust the ZERO potentiometer until the output voltage is approximately zero. Due to leakage through the SCRs some voltage will always be present across the SCR output.

3.3.3 SPAN ADJUSTMENT

Set the maximum control input signal to the SCR, i.e. 10 mA, 10 VDC or 10 K ohms. Adjust the SPAN potentiometer until the output voltage of the SCR is at maximum. Check output voltage again at minimum and maximum control inputs and repeat the zero and span adjustments if necessary.

3.3.4 RISE

The rise adjustment determines the speed that the C3000 responds to a change in the control input signal. Test the SCR response by introducing a step change to the control input and measuring the time it takes for the output to fully respond. Adjust the RISE potentiometer until the desired level of response has been reached.

3.3.5 CURRENT LIMIT AND TRIP OPTION

Current limit and trip must be set with the dummy load removed and the actual load connected. Zero and Span adjustment must be correct before current limit and trip are set.

3.3.5.1 CURRENT LIMIT

The current limit adjustment sets the maximum output current of the controller. When used with the C3000 set to phase angle firing mode it limits instantaneous output current. When used with the C3000 set to burst mode it limits the maximum average current over time.

Set the LIMIT potentiometer fully anticlockwise and the LIM-SL (feedback gain) and TRIP potentiometers fully clockwise. With the control input set to maximum slowly turn the limit potentiometer clockwise until the required current level has been reached. Current limit has now been set.

Note that in general the output current waveform of the C3000 when used in phase angle firing mode is not sinusoidal. For accurate current measurement a true RMS reading ammeter must be used.

3.3.5.2 CURRENT TRIP

After adjusting current limit and with the control input set to maximum, slowly turn the TRIP potentiometer anticlockwise one turn at a time until the SCR current trip activates. Adjust the potentiometer one turn clockwise and reset the trip by breaking and making the 'enable' link or by turning power to the SCR off and on.
Run the controller for a while at full output. If any nuisance trips occur turn the TRIP potentiometer one more turn clockwise, repeating until the nuisance trips stop.

Note that it is possible to set the current trip setpoint lower than the current limit setpoint. Always adjust current limit first and set current trip to trigger at a higher current.

3.3.6 POWER LIMIT OPTION

Power limit sets the maximum output power by measuring output voltage (across two phases) and the average current.

Zero and Span adjustment must be correct before power limit is set.

Set the LIMIT potentiometer fully anticlockwise and the LIM-SLP and TRIP potentiometers fully clockwise. With the control input set to maximum slowly turn the limit potentiometer clockwise until the required power level has been reached. Power limit has now been set. Refer to section 3.3.5.2 to set current trip.

3.3.7 LIMIT SLOPE

The LIM-SLP potentiometer is normally set full anticlockwise. If the SCR output oscillates under current or power limit turn the LIM-SLP potentiometer anticlockwise until output is stable.

3.3.8 CURRENT SOURCE OPERATION OPTION

The C3000 can be run as a voltage limited AC current source. Output current is set by the control input signal. Maximum output voltage is set either by the AUX-V potentiometer on the main circuit card or by an external 10k potentiometer on terminals 9, 10, and 11 or by an external 0-10V DC signal on terminals 9 and 10. To select external control of maximum output voltage remove solder link X4 on the C3000A circuit card.

3.3.8.1 OUTPUT VOLTAGE ADJUSTMENT-CURRENT SOURCE

Connect the controller to a dummy load. With the control input set to maximum adjust the AUX-V or external signal source until the maximum desired output voltage has been reached. A true RMS reading meter should be used for this measurement.

Set the control input to minimum and reconnect the load.

3.3.8.2 ZERO ADJUSTMENT-CURRENT SOURCE

With the load connected set the control input signal to minimum, i.e. 4 mA, 0 VDC or 0 ohms. Connect an ammeter to measure the controller output current and adjust the ZERO potentiometer until the output current is zero.

3.3.8.3 SPAN ADJUSTMENT-CURRENT SOURCE

Set the maximum control input signal to the SCR, i.e. 10 mA, 10 VDC or 10 K ohms. Adjust the SPAN potentiometer until the output current of the SCR is set to the maximum allowable level.
Check output current again at minimum and maximum control inputs and repeat the zero and span adjustments if necessary.

3.3.9 PARTIAL LOAD FAILURE DETECTION OPTION

The partial load failure option give a latched relay output if the load current drops below a preset level set by the user.
Partial load failure will only operate correctly with the controller set to burst firing mode (see section 3.1). Jumper links X6 and X7 on the circuit card marked C3000A determine the operating range of the partial load failure detection option. The table below summarises the operating range for the various jumper configurations.

Jumper	Operating range (% of full load current)
X6	93-100%
X7	86-100%
X6 & X7	79-100%

The potentiometer marked PLF adjusts the trip point within the range determined by the jumper links.

To set the trip point: With the control input set to maximum and the PLF potentiometer set anticlockwise disconnect one heater element. Adjust the PLF potentiometer slowly clockwise until the partial load failure relay trips then reconnect the heater element. Partial load failure is now set to trip at the failure of one heater element.

If the partial load failure trips at all potentiometer positions reset X6 and X7 so operation is over a wider range

3.3.10 METER OUTPUT OPTIONS

Up to three optional meter outputs are available to transmit output voltage, current or power. The output signal is 0-1mA DC

3.3.10.1 ADJUSTMENT-METER 1

Meter output 1 transmits output voltage.
Connect a multimeter to measure 1mA DC across terminals 7(+) and 8(-).
Adjust the output voltage from zero to full and check:
1. the output current is approximately zero for zero output voltage
2. adjust MV potentiometer until current is 1mA at full output voltage

3.3.10.2 METERS 2 & 3

Meters 2 & 3 can be configured to transmit output current, voltage or power if the appropriate options are fitted.

These meter outputs need these options ⇒	Current limit/trip option CL	AC voltage feedback option AVF	Power limit option PWL	Firing mode
Current meter output	●			Either
Voltage meter output		●		Either
Power meter output	●	●	●	Phase

To change the output of meters 2 or 3 select the appropriate solder jumpers on the C3000A card as specified in the following tables.

Meter 2	X14	X15	X16
Current	in	out	Out
Power	out	in	Out
Volts	out	out	In

Meter 3	X11	X12	X13
Current	in	out	Out
Power	out	in	Out
Volts	out	out	In

3.3.10.3 ADJUSTMENT-METER 2

Connect a multimeter to measure 1mA DC across terminals 28(+) and 27(-).
Adjust the output voltage, current or power from zero to full and check:
1. the output current is approximately zero for zero output voltage, current or power as appropriate
2. adjust CM2 potentiometer until current is 1mA at full output

3.3.10.4 ADJUSTMENT-METER 3

Connect a multimeter to measure 1mA DC across terminals 30(+) and 29(-).
Adjust the output voltage, current or power from zero to full and check:
1. the output current is approximately zero for zero output voltage, current or power as appropriate
2. adjust CM3 potentiometer until current is 1mA at full output

4.0 OPERATION

4.1 STATUS LEDS

Indicator leds are provided to alert operators to fault conditions and to show control status during normal operation. They are mounted on the main control card with a second set of mimic leds mounted on the lid of the controller.

4.1.1 POWER

The ‘Power’ led indicates that power is present on the C3000 control circuitry.

4.1.2 POWER OK

The ‘Power OK’ led indicates that all three phases are present and in the correct sequence. If this led is not lit check all phases are present on terminals L1, L2 and L3. If all phases are present but the led is not lit swap two phases around.

4.1.3 ENABLE

The ‘Enable’ led indicates that the enable link is closed and that the C3000 is in operating mode. If this led is not lit check for continuity between terminals.

4.1.4 LIMIT

This led is fitted when current or power limit is specified (options CL, PL) or when the controller is run as a current source (options CCS, CCH, CCA).

When operating in current limit condition the ‘Limit’ led will light.
When the controller is operated as a current source the ‘Limit’ led will be permanently lit provided the load impedance is low enough.

4.1.5 ELEMENT LIFE

This led is fitted when element end of life indication (option EL) is specified. It indicates that the controller is operating at full line voltage and that new heating elements are required, or a transformer tap change to a higher voltage is required (when a tapped transformer is being used).

The EL option is normally used with silicon carbide heaters.

4.1.6 PHASE LOSS

The ‘Phase loss’ led lights when any one of the incoming phases is missing.

4.1.7 TRIP

The ‘Trip’ led is fitted with the current, power limit or constant current options (options CL, PL or CCA). This lights when the controller is disabled on an over current trip.

4.1.8 PARTIAL LOAD FAILURE (PLF)

This led is fitted with the partial load failure option (option PLF). It lights when a partial load failure is detected.

4.1.9 OVER TEMPERATURE

The ‘Overtemp’ led lights when the SCR assembly is over its allowable operating temperature or when terminals J25 and J26 are open. The controller output is disabled until the operating temperature drops below the trip point.

4.2 RESETTING CURRENT TRIP

On current trip the controller is disabled. To reset the controller either break and then make the enable link on terminals 1 and 2 or turn the three phase power to the controller off then on.

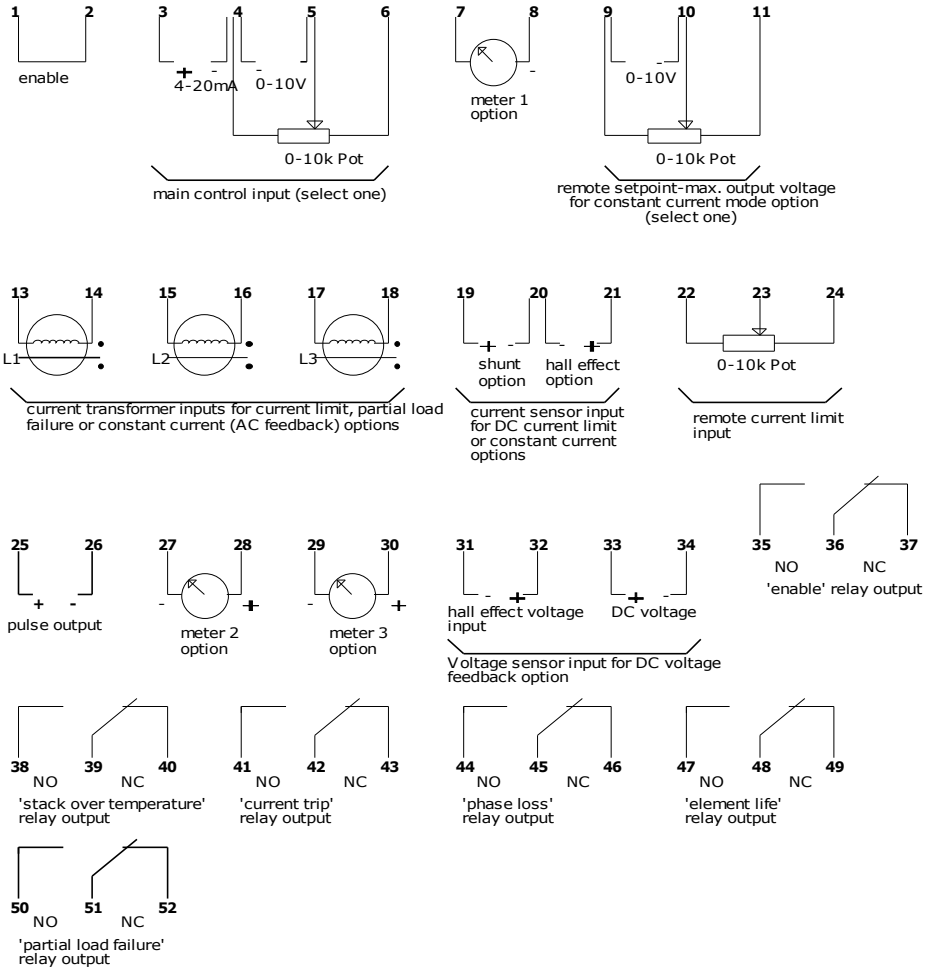
5.0 MAINTENANCE

5.1 TROUBLE SHOOTING GUIDE

Fault condition	Possible cause	Corrective action
No output from SCR	ENABLE link open	Close ENABLE link
	No control input signal	Check input signal and ensure polarity is correct
	Power wiring out of sequence	If POWER OK led unlit swap two input phases
	Input phase lost or missing	If PHASE LOSS led is lit identify missing phase and reconnect Check fuses for continuity and replace if required
	Over temperature trip activated	If TEMP led lit shut off power and allow to cool
	Current trip activated	If TRIP led lit find source of over current trip and correct. Reset trip by turning off power or breaking and making enable link
	Load circuit open	Check load circuit continuity and repair as required
Controller output not modulating with respect to control input	Gate or cathode lead(s) disconnected from SCRs	Reconnect leads
	Gate or cathode leads wired incorrectly (out of sequence) to SCRs	Rewire gate and cathode leads in correct sequence
	Load wired out of sequence on 6 wire load configuration	Rewire load in correct sequence
	Neutral reference not connected on four wire (4W) load configuration	Connect neutral reference
Unequal output current over three phases	Unequal load resistance	Check load circuit
	Gate or cathode leads loose or disconnected	Reconnect leads
	SCR block damaged	Replace SCR

6.0 TERMINAL SCHEDULE

Terminal schedule



7.0 SPECIFICATIONS

Control mode Phase angle or fast cycle burst (user selectable)
Control input User selectable from 4-20mA DC, 0-10V DC, 0-10K ohm potentiometer. Other inputs available on request.
Control range 0-100%
Voltage 110, 240, 380, 415, 480 VAC @ 50 or 60 Hz. Other voltages available on request.
Current Standard range to 340 amps per phase, higher currents to special order
Firing modes Fast cycle burst or phase angle with soft start
Protection RC snubber protection and fast semiconductor protection fuses standard.
Operating temperature 50 degrees C maximum. Thermal cut out standard
Operating humidity 0-85% RH, non condensing
Isolation > 1kV
Status output contacts 2 amps @ 240 VAC

8.0 CIRCUIT CARD LAYOUT